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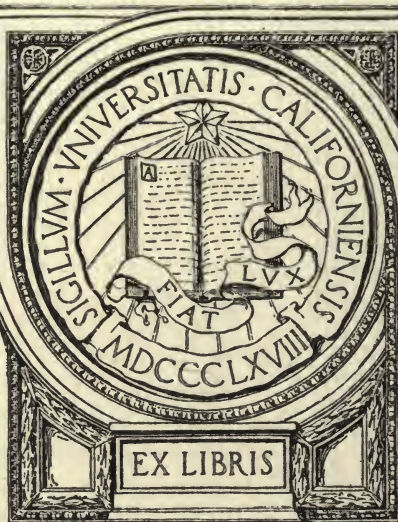
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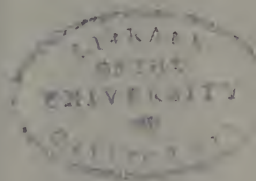


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The McKay Endowment
AND
Applied Science at Harvard



By HENNEN JENNINGS

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AND
Applied Science at Harvard

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The Gordon McKay Bequest

THE contributions sent to the HARVARD ALUMNI BULLETIN by Professors Lawrence J. Henderson, Theodore W. Richards, and William Morton Wheeler give most excellent suggestions as to a new start of applied science at Harvard and the best future use that can be made of the McKay Endowment Fund.

No attempt is here made to tear down their work, but, on the contrary, to support some of their main lines, and at the same time to stimulate further intelligent discussion by making an attempt at surveying the ground leading up to the present condition of things, and making more detailed analysis of some of the operative forces in the problem, and thus better equipping future contributors.

The writer takes a deep interest in these problems as he was a student at the Lawrence Scientific School, obtaining the degree of Civil Engineer in 1877. His knowledge, sympathy, and interest, however, are not wholly marshalled on the technical side of the subject, as his son obtained his Harvard A.B. in 1915, and is enrolled in the Harvard Law School, though now taking his part in France.

While not having had opportunity of meeting Mr. Gordon McKay, the writer, as consulting engineer of the Conrey Placer Mining Co., Ruby, Mont., was thrown in intimate business contact with Messrs. J. J. Myers and F. F. Stanley, directors of this company, as well as trustees of the McKay estate.

Mr. Myers was attorney for Mr. McKay for some years;

he was, besides, first and last a Harvard man. He took his A.B. in 1869, and was also a graduate of the Harvard Law School. He dwelt in Wadsworth House in the College Yard for many years. As president of the Conrey Co., he was ever zealous of Harvard's financial interest, and yet, in duty bound, he felt impelled to stimulate legal action against the Harvard-Tech merger, which caused him sorrow and concern at the time of his death, in April, 1915.

Mr. F. F. Stanley, as secretary and treasurer of the Conrey Co., had dealings with McKay and Shaler in such capacity from the starting of the venture in 1896 up to the time of their deaths, and with the writer from 1906 up to the present time. He was connected with McKay in confidential business relations for over 35 years.

These gentlemen had the highest respect and regard for Mr. Shaler and Mr. McKay; they were also able to give assurance of the close and sympathetic relationship existing between them.

The writer makes no claim to being a trained or competent educator, nor has he ambition in that direction; but, as he has had opportunities as a mining man to obtain the views of others more competent on the subject, he deems it possible that it may give increased weight to his views, should he mention some of them.

As a member of the Departmental Committee of the Board of Education on the Royal College of Science, etc., London, 1904-1905, of which R. B. Haldane—now Lord Haldane—was chairman, he was given opportunity of hearing the views of some of the best-known technical men of Great Britain.

As president of the Institution of Mining and Metallurgy, 1904, he presided at some of the meetings of this institution when the equipment of laboratories for teaching and research in the mineral industries was most earnestly and extensively discussed, contributions to the discussion even being obtained from some eminent instructors in this country.

He was member of the Harvard Visiting Committee on Mining and Metallurgy from 1906 to 1914.

Professor Shaler.

His greatest opportunity and privilege in connection with instructors was his contact with Professor Shaler, who seems to him to have been a prince among educators, an inspiration to his students.

Mr. Shaler not only was great as a teacher but his versatility and power were such that he took a foremost place as a humanist, philosopher, naturalist, and engineer, and, withal, glowed with poetic imagination and kindly humor.

The writer's first meeting with Mr. Shaler dates back to the former's freshman year at the Lawrence Scientific School, in 1873. While sitting in his room—a rather forlorn “scientific pill” (an academic classification given Lawrence Scientific students by their classmates at that time)—a knock at his door brought into his life an influence that can never be taken away. Mr. Shaler had called upon him because he saw his name in the catalogue as coming from Kentucky, and, he explained, there were few Kentuckians at the University and he thought possibly he might be lonely. After this, until Mr. Shaler's death in 1906, the

writer was a welcomed visitor at his home, and kept in touch with him as far as his long absences from this country would permit.

A few weeks before Mr. Shaler's death, the writer visited him in Cambridge and spoke of the wonderful influence Mr. Shaler had exerted on his students during his long teaching career. Mr. Shaler admitted that he prided himself upon two things during his forty years' stay at Cambridge—one, that he had never done his colleagues or students the discourtesy of keeping them waiting at any appointment he had made; the other, that with the thousands of students with whom he had been thrown in contact, he never found any so hopelessly bad that he had to report them to the Faculty, but admitted he had given them some fierce tongue-lashings himself.

The essence of his power was not punishment, but rather sympathy and suasion, and this is beautifully told in the "Autobiography of Nathaniel Southgate Shaler," in the Memoir by his wife, published 1909, pages 374 to 376, wherein she sets forth as follows his relations with students:

The truth is, as time wore on, mere intellectual distinction unaccompanied by high character was held in only moderate esteem; to his mind the supreme excellence consisted in being a gentleman. But in whatever shape it presented itself, whether able-minded or dull-witted, he had great reverence for the organism called man, and was ever conscious of the immense struggle the ages had witnessed to bring him to the place where he now stands. He not infrequently quoted Emerson's saying, that it was something for man to have got up on his hind legs and shuffled off some of his animal propensities. It was this historic sense that enabled him to see the latent significance that lay beneath the smooth-faced

vacancies of the youths that passed before him, and to such of these as would submit to his guidance he was a born director of souls. How many did submit is shown by the hundreds of letters from students acknowledging the help he had given them, the perverted ways abandoned at his stirring call to lead the clean and wholesome life. His willingness to bother, up to a certain point, with men of crooked ways, is all the more remarkable since there was no one who had less call for indulgence than he. Nevertheless, his long experience had taught him to weigh a man's errors against his temptations, and these he felt were to a certain extent involved in the previous conditions of the man's life. He therefore looked upon individuals tolerantly, with a discriminating eye as to their values and their needs, and without being sermonic he sooner or later imparted to them a sense of what was dross and what was gold—a lesson which he himself had so well learned. The fact is, his influence for good was great because he lived on the plane of right doing to which he directed others.

Mr. Shaler's relations with his students were the most vital and interesting of the contacts that came to him. Young men of all degrees and temperaments liked him, not because he spared their faults, was truckling, or sought to be popular, but because he met them on the broad level of humanity; and if in his estimate of them he sometimes gave them credit for what they should be, rather than for what they were, in the long run his judgment was as true as it was generous. The foundation of the attractive power that drew men to him was his manliness and outgoing sympathy; he had a kind word to bridge the deeps that lie between most human beings. Furthermore, when he commended a student, it was with wholeheartedly liberality; when he condemned him it was in a broad and catholic way. Detesting anything like mechanical treatment of a human soul, he refused to be hemmed in by rules or to raise authority to a system of oppression. Each individual was to be treated with reference to his capacities. "The business of the true teacher," he says, "is like that of the gardener who is dealing with hybrids, where the product of each seed is a problem to be studied

at every step of its development, to be fostered by all the resources in the way of soil and climate which can be applied to it through all the resources of art."

What other equipment of experience Mr. Shaler had for his tasks can best be told by again quoting from the same Memoir, pages 217, 218, as follows:

The fervid rate at which men lived in the early sixties of the last century may be inferred from the events which took place in Mr. Shaler's own life before he had reached the age of twenty-two. He already had taken his S.B. degree with honors; had become a captain of artillery; and had chosen his wife. This fervor of a particular period which he shared with others, eventually crystallized into a permanent personal quality, for without fervor he could never have gone out as he did to meet life on all sides. Rich experiences came to him in military and civil affairs, in his work as field geologist, mining expert, director of a state survey, member of various state commissions and of two bureaus of the national government; as traveller, prose-writer on many subjects, and poet. At twenty-three he became lecturer, at twenty-seven professor, and dean at fifty.

Gordon McKay.

His relationship with Mr. Gordon McKay can be best obtained from this Memoir, pages 327, 328, and the justification of giving further quotation from it seems evident, as it speaks well of one to whom Harvard men are so indebted:

Since Mr. Gordon McKay was destined, at a later period, to play so large a part in Mr. Shaler's life and in that of the University, the above allusion to him would seem to call for a word

of explanation. Mr. Shaler's acquaintance with Mr. McKay, one of Harvard's greatest benefactors, began in 1865, and from that time on he knew him intimately until Mr. McKay's death in 1903. Indeed he somewhere says he never knew any man so well or so long. For many years they were very close neighbors, and at first were drawn together by the mutual interest in inventions and mining problems. The side of his character which Mr. McKay presented to his friend was one of great dignity and kindness. Moreover, his mind was constantly reaching out to large enterprises, and in these excursions he sought for sympathy and suggestions from a source which he well knew would never fail him. On his part, Mr. Shaler found, in many ways, great satisfaction in his business relations with Mr. McKay, who could imaginatively project himself into any large enterprise and grasp the possibilities of an unverified hypothesis, whereas with prosaic men of affairs of the average type Mr. Shaler's imagination was often a barrier. Because he saw far beyond the immediate question, they sometimes seemed to doubt his practical grasp of the concrete problem itself. Not so with Mr. McKay; he eagerly followed him in his scientific and practical quests and showed an inspiring faith in his forecasting power as well as in his capacity to meet the unforeseeable difficulty. But aside from the advice which Mr. McKay asked in mining matters, he especially sought Mr. Shaler's counsel with reference to the best uses of money intended for the public good, and particularly the conditions of his own proposed bequests were the subject of continuous discussion. So far from having a predilection for the College, he began with a serious dislike, which it was Mr. Shaler's special task to overcome. Mr. McKay, however, did believe very firmly that the men whose work tended toward applied science had better be educated with those trained in the liberal arts. This conviction remained fixed in his mind until the time came to make his final decision. After 1891 there was no longer a shadow of doubt as to the destination of his fortune, and he always alluded to Mr. Shaler as the one person of all others whom he looked to for the carrying out of his wishes.

Conrey Placer Mining Co.

As a practical miner, engineer, promoter, and administrator, Mr. Shaler has done much for Harvard through his connection with the Conrey Placer Mining Co., of which he was president and chief factor from its inception to the time of his death.

The Conrey Placer Mining Co. is a gold-dredging company in Ruby, Montana, which started in 1898, before large dredging was done in California. It was a pioneer in the size of the dredging machinery employed.

Gordon McKay largely financed the company in the initial stages; thus his estate, and eventually Harvard University, became the chief owner. Mr. McKay took a deep interest in the details of the work, visited Montana with Mr. Shaler, and invented a centrifugal pump for one of the dredges which did, and is still doing, most excellent work.

The initial mistakes and troubles incident to pioneer work had been very largely overcome and the venture put in a sound condition for future profits at the time of Mr. Shaler's death, thanks to his vision, tenacity, and faith, and his power of infusing in others, especially Mr. McKay and his trustees, sufficiency of faith to stand crucial money tests.

The Conrey Co., of which Mr. Charles Francis Adams, Treasurer of Harvard University, is now president, is still working; its profits have enlarged the McKay trust by considerably over a million dollars. This mining venture is scientifically interesting in its details to the gold-dredging industry; it was courageously planned and wholesomely financed.

A full description of the operations of this mining com-

pany can be found in Bulletin 121 of the Bureau of Mines, "The History and Development of Gold Dredging in Montana," by the writer.

Court Proceedings.

The "Proceedings" of the Massachusetts Supreme Judicial Court in the test case as to the legality of the Harvard and Institute of Technology amalgamation, were printed some time before the decision, November 27, 1917, in the case of the President and Fellows of Harvard College vs. The Attorney-General of the Commonwealth of Massachusetts. The Court gave judgment that the agreement entered into between Harvard and the Institute was not in accord with the provisions of the will of Mr. McKay.

In the printed "Proceedings," the testimony, letters, and appended documents are most interesting and instructive in that they give the main features of the McKay Endowment, much history of the Lawrence Scientific School, and the Graduate School of Applied Science, also "An Account of the Gordon McKay Trust," written by Mr. Shaler shortly before his death, and a variety of statistics and educational views given by such great educational authorities as Presidents Eliot, Lowell and Maclaurin.

As comparatively few of the alumni of Harvard have had opportunity of hearing or reading these "Proceedings," it is necessary, in order to make clear the meaning and nature of the McKay Endowment, to give liberal quotation and reference.

Mr. Shaler's account of the origin of the McKay Endow-

ment is full of interest, but it is too long to quote fully. The following, however, ("Proceedings", page 229), seems a fair epitome:

During the various stages in the discussion and growth of the project, which resulted in his will and trust, I was much with Mr. McKay on long journeys, while I served him in a friendly way as a mining engineer. While thus occupied we were together in the field for many months. He was satisfied with the service he had with me, and chose to regard my training as about what he wished to have for the youths who were to be educated by his trust. He knew how my education had combined training in the exact sciences with liberal culture in the atmosphere of Harvard University, and he often told me that he saw the profit of the combination.

From this account, no matter how much one believed in the wisdom of the merger, the equity of the Court's decision certainly is made clear.

Mr. Shaler laid no claim to dominating, dictating, or controlling the McKay bequest, but there is no doubt that he was the inspiration of it, guided some of the details, and was sympathetic with it all.

His life and accomplishments indicate that the soul, brain, and character of the teacher count more, in the uplift and other benefits to the student than an institution of learning can give, than any brick, mortar, housing, or perfection of equipment.

For right comprehension and intelligent suggestion, some of the main facts and principles of technical education as given at the Lawrence Scientific School, the Graduate School of Applied Science, and the Massachusetts Institute of Technology should be clearly understood, and they can be

largely obtained from the reports, letters, facts, and opinions set forth in the "Proceedings."

Lawrence Scientific School.

The Lawrence Scientific School was founded in 1847, second in priority of the technical schools in this country; the Rensselaer Polytechnic School, founded in 1824, was first. The Sheffield Scientific School was third, 1847; the Massachusetts Institute of Technology, 1861; the Columbia School of Mines, 1864.

President Eliot, ("Proceedings", page 68), in connection with the early organization of the Lawrence Scientific School, states:

The students consisted mostly of what we nowadays call special students, or unattached. It had no organized program of instruction. It consisted of these three detached units, and was, of course, feeble in all respects. Nevertheless, it graduated an extraordinary number of men who turned out in later life to be singularly successful.

Some explanation of the success of students may be found in the fact that among the early technical teachers such names appear, as, Louis Agassiz, Benjamin Peirce, Josiah P. Cooke, Eben N. Horsford, Asa Gray, T. Sterry Hunt, Jeffries Wyman, Joseph Lovering, J. D. Whitney, and Nathaniel Southgate Shaler.

In 1877 the number of students in the Lawrence Scientific School amounted to no more than 34. The courses were disjointed, but excellent in spots, the students were made to work for their degree, and thus obtained mental drill. As a whole, there was great aloofness between the

scientific and academic students, but even so, some warm friendships were often made.

The School further dwindled until 1885, when Dean Chaplin took charge; the student enrollment was then only 16. From this time on it took a new lease of life, the courses of instruction were improved and readjusted, the teaching staff was augmented, and the work and the student more woven into that of the College.

Mr. Shaler became dean in 1891, at which time the number of students had increased to 88. In his first report, 1891-1892, ("Proceedings", pages 213, 214), Dean Shaler states:

The remarkable increase in the attendance at the Lawrence Scientific School which has taken place in the last five years, appears to be in the main due to a more widely disseminated knowledge of the advantages which it can afford students who wish to combine a measure of academic culture with a training in some branch of science which will serve as the foundation for a career. At the same time, it is a valuable element in the policy of the School that special effort is made to adapt the instruction to the needs of the individual student, and at the end of the course to place him in a situation suited to his capabilities and training.

The vigor and success with which Shaler developed this policy and further enlarged it while dean is mirrored in the fact that the number of students before his death increased to over 500, of which 270 were in the Department of Engineering.

The students of the Scientific School had access to the chemical, physical and biological laboratories of the University, and special laboratories and plants were provided

for students of applied science, the cost of which, President Lowell stated at the time of the merger, was about \$365,000.

This sum, however, does not apply to the main laboratory equipments of the University, as Dean Shaler in his report from 1893-1894, ("Proceedings", page 217), states:

Since the foundation of technical schools in the United States the very rapid extension of the elective system in the greater colleges has altogether changed their attitude towards professional education.

Moreover, the elective system has made it necessary for the College to create, at a great cost, a number of laboratories and other means of scientific research, all of which are suited to the needs of applied science. The development of these establishments for practical enquiry, with their associated museums, has gone so far that in this University they represent an aggregate investment of about \$4,000,000*. Similar changes have taken place in all the stronger universities of this country.

Further, in regard to laboratories, Dean Shaler's report for 1898-1899, ("Proceedings", page 221); gives the following:

It may be well to note that in the project for the laboratories in mining and metallurgy it is not proposed to do more than illustrate the principles involved in the various methods of treating ores. Thus, while the establishment is to include the usual tools, stamps, vats and so forth, so that samples may be passed through the series of operations and the theory of these processes thereby made clear, the aim will be to limit the work strictly to this purpose of illustration and experiment. Those who have charge of instruction in this department believe that little relating to the craft of this and other technical arts, can or should be taught in a school; the

*No doubt in this estimate the Agassiz Museum is included.

technique is profitably learned in those places only where the work is conducted with a view to profit. Therefore the students in this department are required to spend the larger part of one of their long vacations in mines and metallurgical works, where they may observe the economic application of methods with which they have become familiar in the laboratory.

The following quotation from President Eliot's report for 1889-1890 ("Proceedings", pages 210, 211), throw additional light on the accomplishments at the Lawrence Scientific School:

The Lawrence Scientific School has within three years so added to its numbers that it is larger in the current year than it has ever been before, since its foundation in 1847. The number of students was 35 in 1888-89; 65 in 1889-90 and 88 in 1890-91, the numbers being those given in the annual catalogues, and being therefore a little below the numbers annually reported by the Dean. There is reason to believe that this growth will continue. The five courses of instruction which lead to the degree of B.S. are all thorough and well-arranged; the admission-examination is within the capacity of any graduate of a good high school; and through the intimate association of the School with the College its students enjoy all the privileges in Cambridge which College students enjoy.

In his report for 1897-1898 ("Proceedings", page 219), the social relationships of the students are set forth as follows:

The status of the scientific student in Cambridge has completely changed within ten years; he is no longer an outsider, but a comrade and equal of the College student in every respect. He has the same rights in the same buildings and associations, is eli-

gible to the same clubs, teams, and crews, shares with the candidates for the A.B. the delights and charges of Class Day, and graduates on the same day after the same period of residence. In proportion to its numbers, the Scientific School furnishes more members of the principal athletic teams than the College does; and last spring more undergraduates, in proportion to its number of students, enlisted in the army or navy from the Scientific School than from the College.

Graduate School of Applied Science.

President Eliot gives an outline of the birth of the Graduate School of Applied Science, pages 109, 110, of the "Proceedings", as follows:

The establishment of the Graduate School of Applied Science was a step in a long process which had been going on for nearly forty years. It began when I became president of Harvard University. That process was the giving of all the preliminary and elementary instruction in what we may call the applied sciences, not in a separate school called the Lawrence Scientific School, but to young men entering upon the full elective privileges of Harvard College, with a requirement for admissions somewhat lower than those which lead into Harvard College. There developed with that policy certain prescribed programmes of instruction in all the different branches of applied or industrial science, such as mechanical engineering, civil engineering, electrical engineering, mining engineering. Those programmes of study were carried out at first by students registered in the Lawrence Scientific School, but later by students registered in Harvard College; and the great growth of the school was due to the institution of these programmes for preparing engineers, chemists, miners, etc., which could be carried out by the student in Harvard College, simply by availing himself of the broad election of studies which is there offered.

Presidents Eliot, Lowell, and Maclaurin.

President Eliot testified that he became president of Harvard University in 1869, prior to which he had been tutor and assistant professor at Harvard for nine years; that he was connected also with the Institute of Technology the first year of its organization and was a member of that Faculty for four years. He was president of Harvard for forty years.

President Lowell testified that before he became president in 1909 he had been a professor at Harvard since 1900, and a lecturer for three or four years previously. He stated that he had been a member of the Corporation of the Institute of Technology since 1890 and a member of its Executive Committee for four years, and was one of two members appointed from 1903 to 1905 by the Institute to negotiate with Harvard as to a union of the two institutions.

He stated that in 1909, there were only 36 students of the Graduate School of Applied Science in the departments that were merged with the Institute of Technology, but that at the time of the merger (in 1915) there were 53 students. He evidently was of the belief that there was no tendency towards any great increase in student material either in number or in quality.

He expressed a belief in the advantage of large numbers of students rather than small, on grounds of both educational value and economy, but made the statement, "The value of education comes quite as much from one's fellow-students as from the instructors, and a certain sized body of students is essential for the best results."

Dr. R. C. Maclaurin testified that he had been president

of the Massachusetts Institute of Technology since 1909; had graduated at the University of Cambridge, England; had received educational training in Scotland, New Zealand, and Canada; and also, had been a professor at Columbia University in this country.

In his testimony he gave but meager information as to the theoretical nature of the courses given at the Institute, no doubt feeling satisfied that they were sufficiently set forth in the printed literature concerning the Institute. Certainly its "Bulletin" for 1916 assures its students of comprehensive, technical education.

He dwelt on the importance of student numbers and the advantages of laboratory equipment. In number of students pursuing courses in branches of engineering, he ranked the Institute with Cornell and Michigan, each having over 1,000 students.

Universities and institutes giving instruction in these branches and which numbered between 1,000 and 500 students, he placed in numerical importance, as follows: Illinois, Purdue, Pennsylvania, California, Wisconsin, Rensselaer, University of Pennsylvania, Stevens Institute, and Missouri.

Between 300 and 200, he gave: Columbia, Princeton, and Johns Hopkins.

Further, he stated: "The Sheffield Scientific School . . . is a little less than 400."

The four great universities of the country,—Harvard, Yale, Princeton and Columbia,—he placed at the foot of the list.

He showed that the Institute of Technology had splendid

new buildings, costing about \$4,530,000, with generous new equipment, costing \$840,000, totalling over \$5,300,000; that the endowment of the Institute amounted to \$9,500,000; that it enjoyed from the state and federal governments an annual grant of \$122,000; and received from students an income of \$500,000.

He indicated that the upkeep of the joint school with Harvard was \$628,000 per annum, of which Harvard would pay \$100,000; and that the total expenditure of the Institute amounted to \$1,043,3000.

In connection with the yearly grants to state universities, he made the interesting statement that California received \$3,742,000, Wisconsin \$3,094,000, and Illinois \$2,845,000.

From the Harvard Treasurer's report for the year ended June 30, 1917, it appeared that the total funds and gifts in the hands of the President, Fellows and Treasurer were \$32,436,394.34, which, at five per cent. per annum, would yield about \$1,621,819.72 in interest. The general summary given in the Harvard Catalogue for 1915-16, pages 280-281, gives the total enrollment of students in the University proper as 5,226, while, including university extension and small schools, the total amounted to 6,306. The number of teachers, officers, and other employees connected with the University was listed at 1,076.

Endowment Fund.

The Harvard McKay Endowment Fund has been built up gradually from the income of the McKay estate, and will continue to increase until the last annuitant of the es-

tate dies; in the meantime, the management of these funds will rest entirely in the hands of its trustees.

No opportunity was given Harvard University to expend any portion of the bequest until eighty per cent. of the accumulated income from the McKay estate had amounted to \$1,000,000, when it was to be turned over to the University. This was done in 1909, but even thereafter only the income from the fund could be made use of; each year the Endowment Fund was to be enlarged by eighty per cent. of the income receipts obtained by the trustees and by them turned over.

In this way, up to January, 1917, Harvard had received \$2,247,261, and a valuation of the capital fund then in the hands of the trustees amounted to \$5,324,973.

Mr. Howard Stockton, actuary, ("Proceedings", pages 180-181), made an estimate based on the probability of the last annuitant dying before 1956, in which case, at that date the fund, allowing interest at $4\frac{1}{2}$ per cent., should amount to:

Total to Harvard of 80% payments,	\$9,244,561.12
Total of 20% Reserve Fund,	8,379,365.00
Capital Fund,	5,324,973.08
Total,	\$22,948,899.20

The main provisions of the Endowment, ("Proceedings", pages 5, 6), are here given:

The net income of said Endowment shall be used to promote applied science:

First. By maintaining professorships, workshops, laboratories and

collections for any or all of those scientific subjects, which have, or may hereafter have, applications useful to man and

Second. By aiding meritorious and needy students in pursuing those subjects.

Inasmuch as a large part of my life has been devoted to the study and invention of machinery, I instruct the President and Fellows to take special care that the great subject of mechanical engineering in all its branches and in the most comprehensive sense, be thoroughly provided for from my Endowment.

I direct that the President and Fellows be free to provide from the Endowment all grades of instruction in applied science, from the lowest to the highest, and that the instruction provided be kept accessible to pupils who have had no other opportunities of previous education than those which the free public schools afford.

I direct that the salaries attached to the professorships maintained from the Endowment be kept liberal, generation after generation, according to the standards of each successive generation, to the end that these professorships may always be attractive to able men and that their effect may be to raise, in some judicious measure, the general scale of compensation for the teachers of the University.

I direct that the professors supported from this Endowment be provided with suitable assistance in their several departments by the appointment of instructors of lower grades, and of draughtsmen, foremen, mechanics, clerks or assistants, as occasion may require, my desire being that the professors be free to devote themselves to whatever part of the teaching requires the greatest skill and largest experience, and to the advancement of their several subjects.

I direct that the President and Fellows be free to erect buildings for the purposes of this Endowment, and to purchase sites for the same, but only from the income of the Endowment.

I direct that all the equipment required to illustrate teaching or to give students opportunity to practice, whether instruments, diagrams, tools, machines or apparatus, be always kept of the best design and

quality, so that no antiquated, superseded, or unserviceable implement or machinery shall ever be retained in the lecture rooms, workshops or laboratories maintained from the Endowment.

Finally, I request that the name Gordon McKay be permanently attached to the professorships, buildings, and scholarships or other aids for needy students, which may be established, erected or maintained from the income of this Endowment.

Should the said President and Fellows of Harvard College fail to accept (in writing) the above Endowment upon the terms and provisions above set forth within two years after my death, I then give said accumulations and said residue to my trustees hereunder and their successors, in trust to apply the same to the purposes above set forth.

Discussion.

Harvard College, founded in 1636, is the oldest in the country. It was the first to start the experiment of linking up applied science with its other university courses.

The older a university is, the less was science known and appreciated at the time of its founding and the more its ideals and methods conformed to church and medieval instruction. Thus the incorporation of scientific training at Harvard was more difficult than its adoption by a younger institution. The Harvard motto, "Christo et Ecclesiæ," fostered the belief that truth and God could be obtained only from within and that true religion was the highest outcome.

Modern science asserts that truth and God can best be found from without, by rightly unsealing, unfolding, and reading the leaves of God in nature. This, when done in lofty spirit, is the highest definition of science—both pure

and applied. It would appear in this age that we must have both religion and science to guard and uphold worthily our motto "Veritas," and the more intimately and harmoniously they are linked together the safer is the premier-ship of our University.

President Eliot had a very hard task and struggled for forty years to find a way to get Harvard to incorporate applied science into its being. Though the Lawrence Scientific School started with brilliancy by the prophetic finger-pointings of Benjamin Peirce, Louis Agassiz, and other great instructors, they gave no accurate charts of guidance and it soon sadly languished. President Eliot did not give up the struggle but called to his aid Dean Shaler, who was a great humanist as well as a brilliant and inspiring lecturer, and success seemed imminent at the time of his death.

After Mr. Shaler's death, the pathways became confused. The one leading to the Massachusetts Institute of Technology seemed the broadest, easiest, and most desirable, but through the court decision, it ended only in a *cul de sac*.

The financial possibilities of the McKay Endowment have been set forth, and they are such that in a material way it is wise for Harvard to obtain them, but her "Veritas" demands that she should earn them.

The conditions of the Endowment at first sight are bewildering, for they do not include in their equations of direction specific constants of time or dimensions. However, this is more subtly taken care of by the snowball growth of the Endowment Fund than is at first obvious, for, while the directions give extreme latitude in detail to the execu-

tives at Harvard, it limits them by placing automatic appropriation in the hands of the McKay trustees.

The waste that might be incident to duplication of effort in technical training by two great institutions so closely located as Harvard and Tech., is better taken care of by the bequest than is generally supposed, as the very terms of the Endowment prohibit wasteful immediate competition in brick and mortar, or student numbers, and there would at this time seem great need for both.

President Maclaurin fortifies the above statement in his report, "Bulletin," 1915-16, as follows:

The rapid growth of the Institute in recent years makes it clear that our new buildings are none too large and that in several departments we shall soon have to face the problem.

For many years there has been a steady growth in the number of students coming to the Institute from the colleges. This year there were more than 17% who were graduates of colleges, the corresponding number last year being 290, and the number of students who have spent one or more years at some college before entering, 559.

In this "Bulletin" the number of students in the different courses at the Institute are given. About twenty courses are enumerated. Mechanical engineering heads the list with 279 students; electrical engineering is second with 235; civil engineering is next with 188; and chemical engineering with 157. No instruction is given in the classics, but there are courses in English and other modern languages, and also political economy.

It is evident that Mr. McKay believed in making haste slowly, and desired that the accomplishment of his objects

should come by degrees, rather than by leaps. He was not impressed by mere mass-showings of students or by grandeur or magnitude of architecture to make the world appreciate immediately his gift. He was free enough from vanity and big enough to wait, and let time give the verdict as to his wisdom.

Does it not appear that democracy is now in danger of over-worshipping the power and might of mere numbers in its voting units, irrespective of quality or their truthfulness?

It would seem that Mr. McKay with his money and Professor Shaler in his teachings had other thoughts in view than the wholesale training of the rank and file of the engineer technicians, which is being done so well at the Institute and other technical schools of the country.

They evidently desired to attract to Harvard future leaders and uplifters of science and engineering, and to give them a better chance to take their proper places and have the importance of their work better understood in the world; they aimed for quality, not numbers, and desired for their students the broadening and mellowing influence of the fine arts. The contact and social companionship with the future choice spirits in other professions at the most formative period of life, they believed, would make their students better able to hold their own among men.

No doubt they also held the vision that the highest representatives of science—both pure and applied—could demonstrate to the world not only the exceeding might of their calling, but also its truth and beauty.

Most of the provisions of the bequest are easy to carry

out, as great latitude is given in details, and all of them seem to the writer possible and desirable if undertaken in a sympathetic, believing, willing spirit. At first it was thought that a serious stumbling-block in the way was the direction that courses should be kept accessible to students who had no other opportunities of previous education than those which the free public schools afford. • This does not seem insurmountable since the Boston high schools send their graduates direct to Harvard, and it would also appear that one of the great advantages of the Freshman Dormitories at Harvard is that it permits students to enter the University earlier and get through the college and professional training, as well as to mix intimately together, before they are overtrained and stale for the race of life ahead of them.

It would seem that there is nothing to prevent immediate erection of buildings with the interest of the funds from the Endowment if the buildings bear the name of Gordon McKay. A certain amount of such construction appears desirable and permissible by borrowing money for this purpose and by paying the interest and sinking funds on such loans from the interest of the Endowment Fund. This right, however, should in fairness be only moderately exercised.

The instructions as to equipment are more specific, but still general. They state that such equipment employed should be up-to-date and best of its kind. It would appear that Professor Shaler meets this difficulty in the quotation given on page 15 regarding laboratories.

Especially interesting is his statement as to the desirability of mixing laboratory equipment and practical study with

up-to-date practice in the mine, shop, metallurgical works, etc. With this I am in thorough accord, if the necessary arrangements can be made with the managers of the works to have it carried out.

The engineer is the closest connecting link between capital and labor in any employment, and he should thus know and be sympathetic with both. In student days he is given his only opportunity of being a fellow-laborer, as afterwards he develops from a small to a big boss.

The clause reading,

Inasmuch as a large part of my life has been devoted to the study and invention of machinery, I instruct the President and Fellows to take special care that the great subject of mechanical engineering in all its branches and in the most comprehensive sense, be thoroughly provided for from my Endowment,

would seem to propose what is most desirable not only for the student but for Harvard University itself. In fact, Mr. McKay was prophetic in his estimation of the importance of mechanical engineering. Its scope and meaning are greater than is at first apparent, for, taken in its most comprehensive sense, mechanical engineering demands, of its leaders sound, if not thorough, knowledge of the principles of civil, mining, electrical, in fact, almost all other branches of engineering, for they are now so closely allied and interdependent that they must do team-work in order to be effective.

In the court proceedings it was implied, if not openly stated, that the student material entering the Scientific School at Harvard was not equal in quality to that going to the

College, and that some very dull and undesirable units gained admission to the College by this door.

It would seem that the McKay bequest greatly aids this aspect of the problem by its provision for scholarships and for adequate salaries to the teachers. They can be made prizes of merit as well as need, and helpful in establishing in the future Scientific School a *corps d'élite*, which Professor Henderson so happily recommends. Mr. McKay in no way aimed to aid merely the mediocre, though worthy, student without talent or funds, but quite the reverse; the bequest shows his desire to have the school enfold and train leaders of future engineering thought and action. Scholarships to students and high salaries to professors and teachers should be regarded as paving the way to the enrollment of the higher class of students, as well as teachers. For the student, it takes away the barrier of poverty, if desire and talent are great, while to the best teachers, it allows adequate money reward. There is no intimation that the students who can afford to do so should not pay for their privileges.

The new Harvard scientific school, while not making claim to great numbers, should do everything to be classed as a *corps d'élite*. It certainly will have money enough for the experiment. It should be made a great privilege to enter the School, obtainable only by competitive examination. In the entrance examinations the number of subjects need not be many, but thoroughness in those demanded should be insisted upon.

Only a limited number of students should be taken at first, and their number should be increased as funds become available. It would seem desirable that the highest salaries

should be paid professors in the freshman and sophomore years, who should be selected from among men of high scholarship, supplemented with practical accomplishment and knowledge of men. They should have the power of creating a thirst for knowledge and laying foundations by making clear and interesting the simple and seemingly obvious. Erudite refinements should come later.

You can take a horse to water, or a student to a fountain of knowledge, but you can make neither drink unless he is thirsty. If the thirst is there, it is simple to slake it in the University.

There is no doubt that a thorough, complete merger of Harvard and the Institute would, on the grounds of economy and efficiency, have much in its favor; but it must be thorough and whole-hearted to make it worth while. A complete merger of the two under the mantle of Harvard would seem the only way, not only for the sharing of the McKay Endowment, but for making the union effective.

A greater Harvard is a big thought, but it seems destined not to be realized. I quite understand and sympathize with the reasons that prevent it; they are not of a material but of a sentimental nature, and they involve two distinct classes of alumni, both with pride of tradition, both believing that they can stand alone, and both confident of their future strength.

The writer is in hearty accord with President Lowell when he says: "The value of education comes quite as much from one's fellow-students as from the instructors, and a certain sized body of students is essential for the best results." Certainly, the Harvard mantle, in point of num-

bers, would in mass effect, be greater than what the Institute could offer.

No mandate of authority will make two sets of students blend in harmonious social accord unless the desire comes from and is fostered by the students themselves; and unless one can blend the alumni of Harvard and Tech., how is it possible to give to the present students the best in student life by dividing their loyalty and traditions?

It does not seem fair to the McKay students to ask them to be placed in a position in which their parent colleges do not unite in pride of their birth. It savors of an illicit union or clandestine marriage.

What Harvard could give and what the Institute could not give in a material way may be illustrated by the statement that an engineer's report may be perfect in technique and sound in all its conclusions, but absolutely worthless in practice if it is not understood or appreciated by the reader who has the power of decision. In other words, it is necessary for those in authority to have some educational insight, if not training, and contact with the engineer, to understand his recommendations, as also to safeguard himself from disaster due to action without comprehension.

The Institute does not pretend to be a good training ground for the future statesman, writer, politician, lawyer, journalist, banker, and business man. The throwing together in formative years of the youth of these several professions and putting them in social and athletic accord and ambition, will result, naturally, in later years, in a better understanding of one another's professions, as well as individual characters.

Alumni gatherings, from time to time, bring them in close and understanding touch in after life.

The engineer has for building material, stone and minerals, which he cannot bend, twist, or distort to cover mistakes in detail calculation or final judgment. He must stand by the results and may be ruined by miscalculation. He thus must seek for eternal verities rather than beautiful word architecture.

Contact with other professional men and a better knowledge of the fine arts may result in more flexibility of thought and expression in the engineer; less dull mechanical ways of looking at life; give him greater knowledge and power to take his place in the legislative halls of the nation and at the council tables of big business; and present opportunity of having his work passed upon and appreciated by representatives in his own profession.

On the other hand, the word-architects can be made more conservative and useful by becoming more conversant with the principles and individuality of basic fact builders, and believing more in the necessity of checking inspirations by outside facts.

Thus, geyser word-outpourings of internal discontent, often stimulated and pioneered in seats of learning, and particularly in Russia, may be restrained, Bolshevik experiments may be avoided, and democracies better saved from themselves and made more worth while to live in.

In an address on "Mining as a Profession," delivered before the Columbia School of Mines, May, 1914, by the writer, there was incorporated a set of diagrams which show for the United States the progressive growth of the

outputs of gold, coal, petroleum, iron, copper, as also the progressive membership in the civil, mining, mechanical and electrical engineering societies in this country from 1800 to 1913. It is regretted that the chemical societies were not included, but they have been in close sympathy with the others. The growth of population, railway mileage, and deposits in all the reporting banks are shown as far back as records exist.

It is most interesting to note, first, the lack of parallelism of the curve for growth of population with those for railways and bank deposits, which were far more sympathetic with the 'upward plunges' of the curves for mineral outputs.

The most startling thing connected with the diagrams is the showing of the magnitude and newness of great mining. The growth of the engineering societies is also shown in close parallelism with the mineral output curves.

The following table gives the date of starting growth, and membership in 1890 and at present, of these societies:

Society	Start growth about	Membership		Percent Increase since 1890
		1890	1917	
Civil Engineers,	1871	1,300	8,600	561
Mining Engineers,	1872	1,900	6,587	246
Mechanical Engineers,	1880	1,000	9,000	800
Electrical Engineers,	1885	500	8,900	1680
Chemical Engineers,	1876	2,750	11,000	300
Total,		7,450	44,087	600

The diagram for the world's mineral output is a fair parallel to that of the United States, and, taken together, they seem to justify the statement that since Mr. McKay made his bequest in 1891 far more coal, iron, copper and petrole-

um have been taken from the earth than in the whole previous existence of the world.

The force generated, confined, and made effective by the engineers is in proportion to the mineral outputs, and thus during the last few years, it has amounted, in muscular energy, to millions, even billions, of strong men units.

The diagrams give also the key to the sudden wealth of the world, the restlessness and lack of adjustment and happiness of some of its people. It has been too sudden for wholesome digestion.

They also show why this war is so largely a war of engineers and chemists. Are they not the marshallers of obedient servitors, very many times stronger in muscular force than all the men in the combined armies of the world? Do they not also give some insight into the causes leading to the present great war? Too greedy drinking at the force fountains!

A number of shining milestones of crucial discovery and invention could be set forth, showing how one invention has led to another, and how engineering of today has grown on the practice of the past, but this is not possible in the scope of this paper.

It may be wise to dwell on three discoveries, or inventions, that have been developed since the McKay Endowment was established; namely, the automobile, the aeroplane, and the securing and fixation of nitrogen from the air.

The seed of the automobile was sown by the slow, lumbering Trevethick steam carriage in 1802—over 116 years ago—but it was not until after the making of the McKay bequest that the petrol and gasoline automobile had its devel-

opment. Its creation was a triumph of the patient endeavor of mechanical engineering, supplemented by the help of the engineering 'brotherhood'; it has given man racing chariots so swift that the accomplishments of those in the stadiums of old seem tortoise marches. The speed chariots have been followed by other motor vehicles now considered almost a necessity.

Is it not lack of all-round culture not to know why the automobile runs?

Langley's aerodrome, though sound in principle, made its false start only in 1896. By aid of the mechanical engineer, the Wright Brothers' flight was made possible in 1908.

Again, has not the prosy mechanical engineer, with his brethren, given man wings swifter and stronger than those of the eagle, and which may prove the decisive factor in this terrible war?

Is it not ignorance not to have some comprehension of why the aeroplane flies?

The manufacture of nitrogenous compounds from the air is a matter of only seven or eight years past. In this the chemist takes first place, but he had to be backed by his brother engineers. The significance of the accomplishment is that man has obtained from the air the most necessary ingredient for his thundering guns. It calls to mind the Prometheus fable, for man has stolen Jupiter's thunderbolts, and possibly is being punished for his presumption by the slaughter of his best youths by the Krupp shells. There is balm even in this, for if we look deep and far enough we find that the nitrogen thunderbolts filched from the air can be made into fertilizers as well as shells and make

two blades of grass grow where before there was but one.

Will it not soon be a brand of ignorance not to know how man has been able to steal Jupiter's thunderbolts?

What, in fact, is the meaning of the great manufacture and distribution of force that has taken place of late years? Is it not again the scientist, inventor, and engineer in all branches who has created an Aladdin's lamp which, when properly rubbed, brings millions, yes billions, of obedient servitors?

Have not the men who have done these things much to give? Their mental and character fibre will be crucially and thoroughly tried out by the cleansing fires of war, and, although they may come out of it less in numbers, I am bold to prophesy they will in courage and efficiency come through unscathed.

Alumni of Harvard, have you not as great need for such men in your halls and annals as they have need of you?

The war will certainly accentuate the usefulness and importance of the great engineers in all branches of the profession, and the student material will be more and more desired by the universities and schools of this country.

Harvard cannot obtain the best students merely by using the money from the McKay Endowment. Harvard University must make them feel—and give expression through its President, Fellows, teachers, students, and alumni to the thought—that it needs and wants the student of science, both pure and applied, to round out and make perfect and enduring its best culture, and that it welcomes the scientific student heartily and does not consider his training a burden.

Unless this can be done, it is right and natural for the student of applied science to go where the "glad hand" awaits him.

The writer is of the belief that Harvard has now the material resources within its grasp to lay the foundations for an applied-science department second to none in this country in point of excellence and usefulness. The work, however, must be undertaken with courage and hope, and no patchwork arrangement with the Institute allowed to dull and paralyze initiative and effort.

There is need for all that both Harvard and Tech can give for the training of the future engineer, and the fear of wasteful and overlapping effort seems to the writer more imaginary than real; wholesome, friendly competition in similar fields might result in a good tonic to both, rather than any serious detriment.

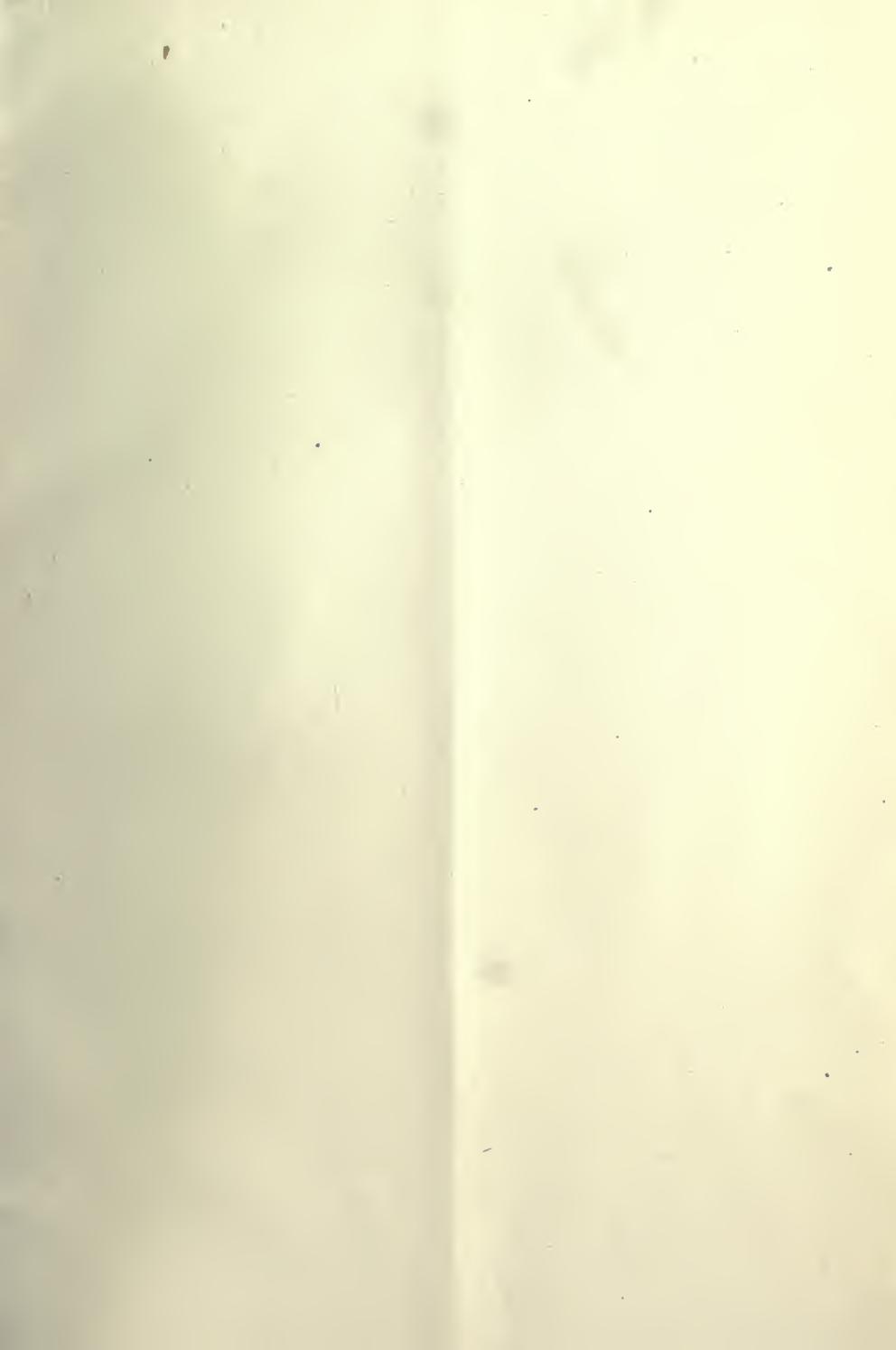
Effort has been made here to show that Harvard University, between 1885 and 1906, had incorporated in her teaching and student body a thriving and progressively-growing scientific school without such material aid as the McKay Endowment Fund now permits.

In the foregoing the writer has tentatively given suggestions which he considers helpful and wise for the future, but he does not pretend to have elaborated them or put them in form for final usefulness. His hope is that this article will give information which others have not had so much opportunity of obtaining as he has had, and that his suggestions may be stimuli for further and better suggestions.

In conclusion, it may be said that one of the great and good things of the McKay Endowment is that it permits

experiments and even false starts without great injury to the final usefulness of the Endowment Fund. The sooner, however, comprehensive plans for slow growth are laid down and cultivated, the greater its usefulness in this generation.

Washington, D. C.,
February, 1918.



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